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Osada

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(54) **ELECTRICAL CONNECTOR ASSEMBLY COMPRISING LOCKING PART**

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(52) **U.S. Cl.** **439/188**; 201/51.1
(58) **Field of Search** 439/188, 352, 439/350, 357, 509, 512, 510, 514, 515; 200/51.1, 51.09

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(57) **ABSTRACT**

An electrical connector assembly of the present invention comprises (1) a socket for supporting two pairs of first electrical connector elements in proximity; (2) a plug for supporting two pairs of second electrical connector elements, which are to be engaged with the two pairs of first electrical connector elements, respectively; (3) two short-circuit elements, fitted in the socket, for electrically short-circuit the two pairs of first electrical connector elements, respectively; and (4) a locking element which is locked at a first position with respect to the plug and, when the plug is engaged in the socket, becomes movable to a second position at which the locking element forces the two short-circuit elements to move back to their non-short-circuit positions simultaneously. This can provide an electrical connector assembly having a locking part that can provide a drastically improved working efficiency and thus provide excellent connection workability even when two pairs of electrical contacts are connected with each other.

4 Claims, 17 Drawing Sheets

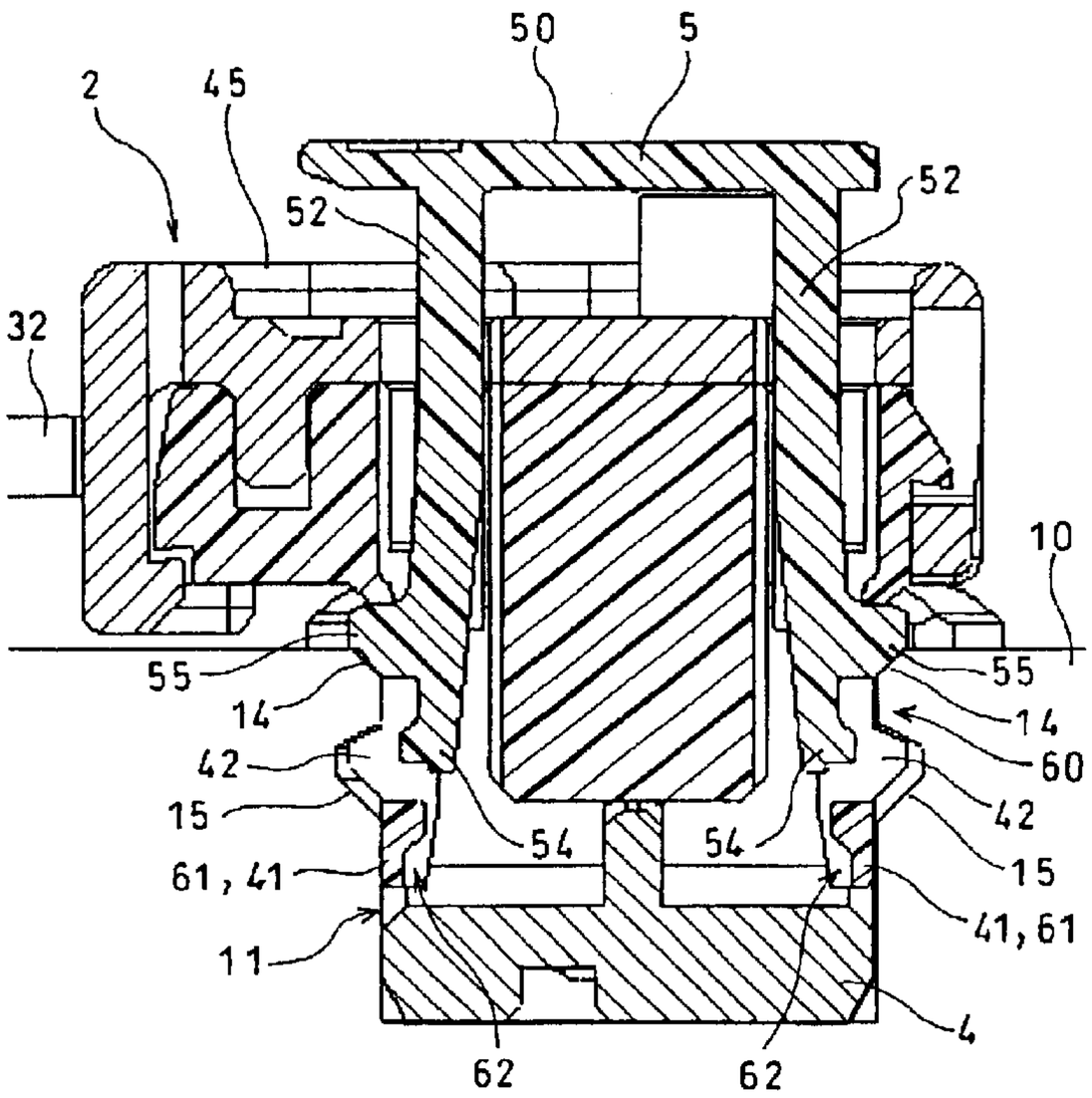

FIG. 1

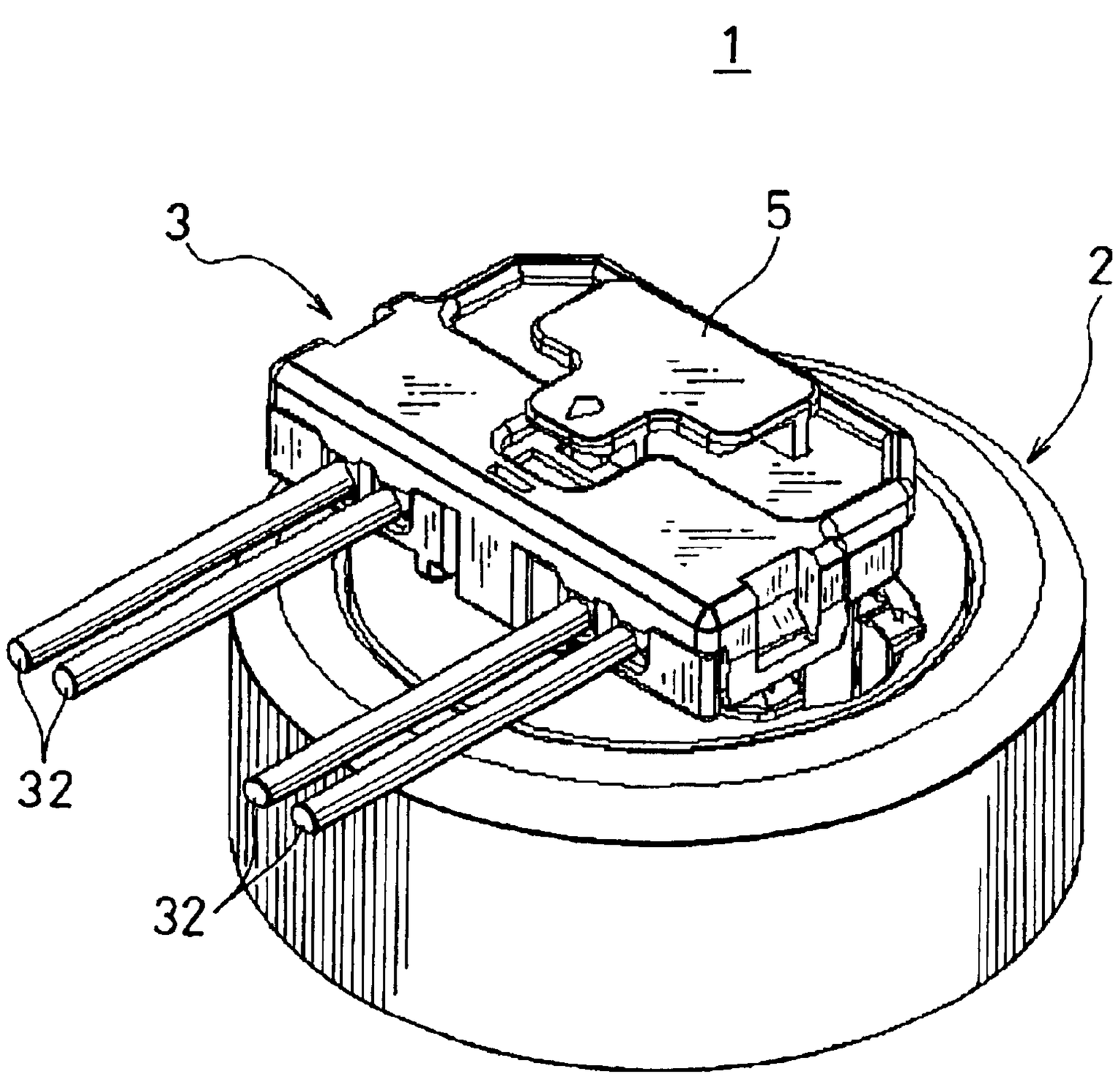

FIG. 2

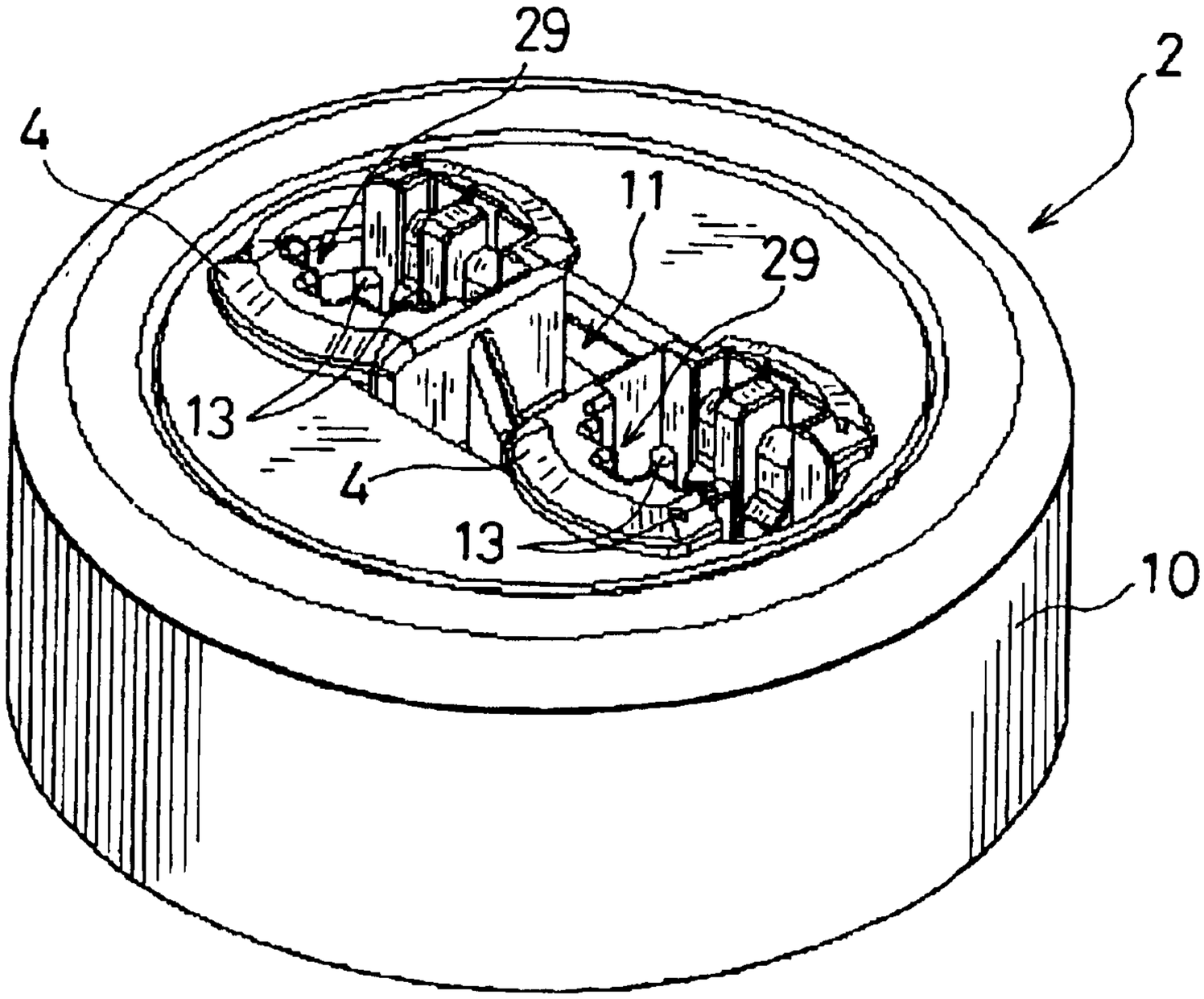

FIG. 3

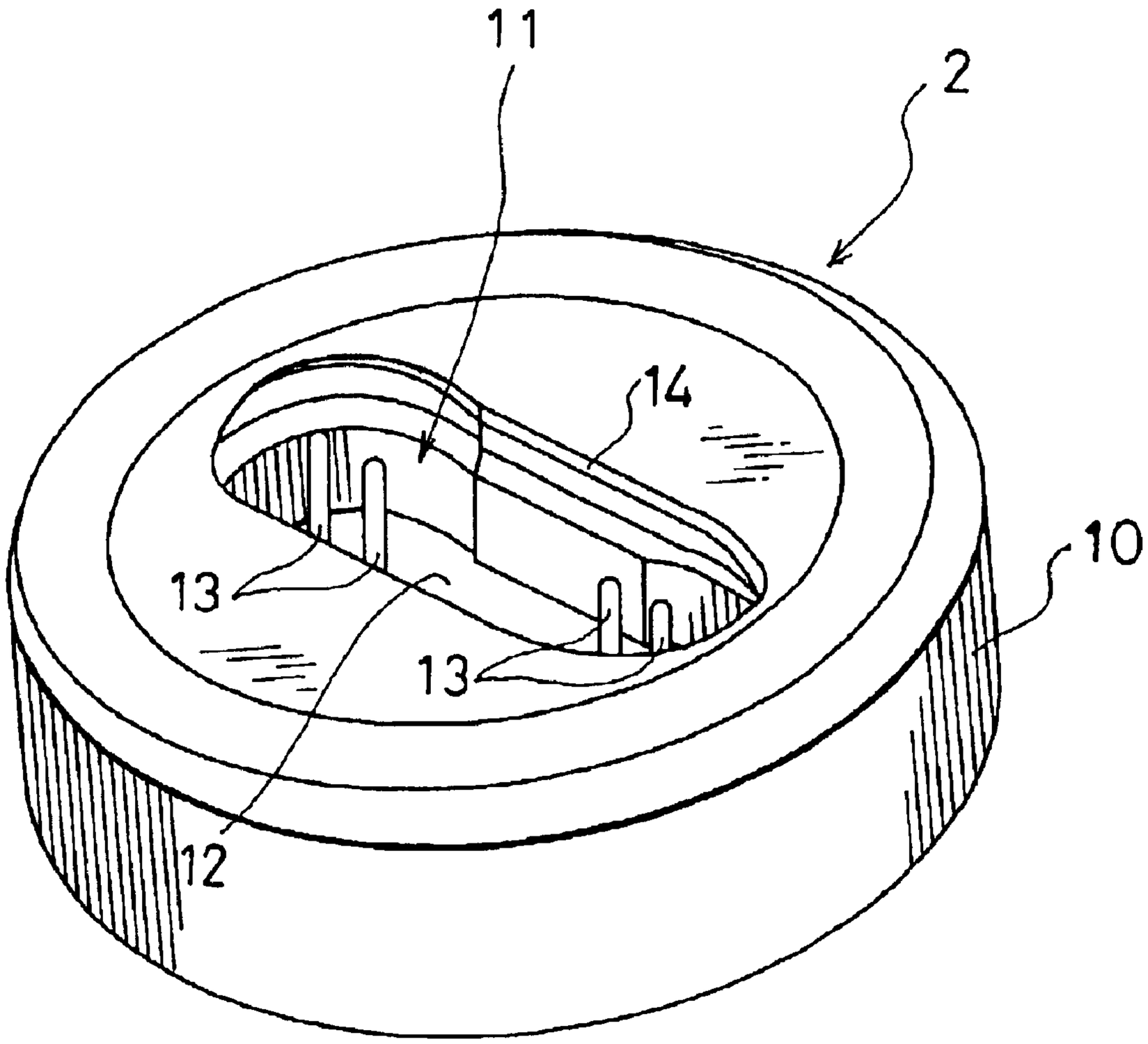

FIG. 4

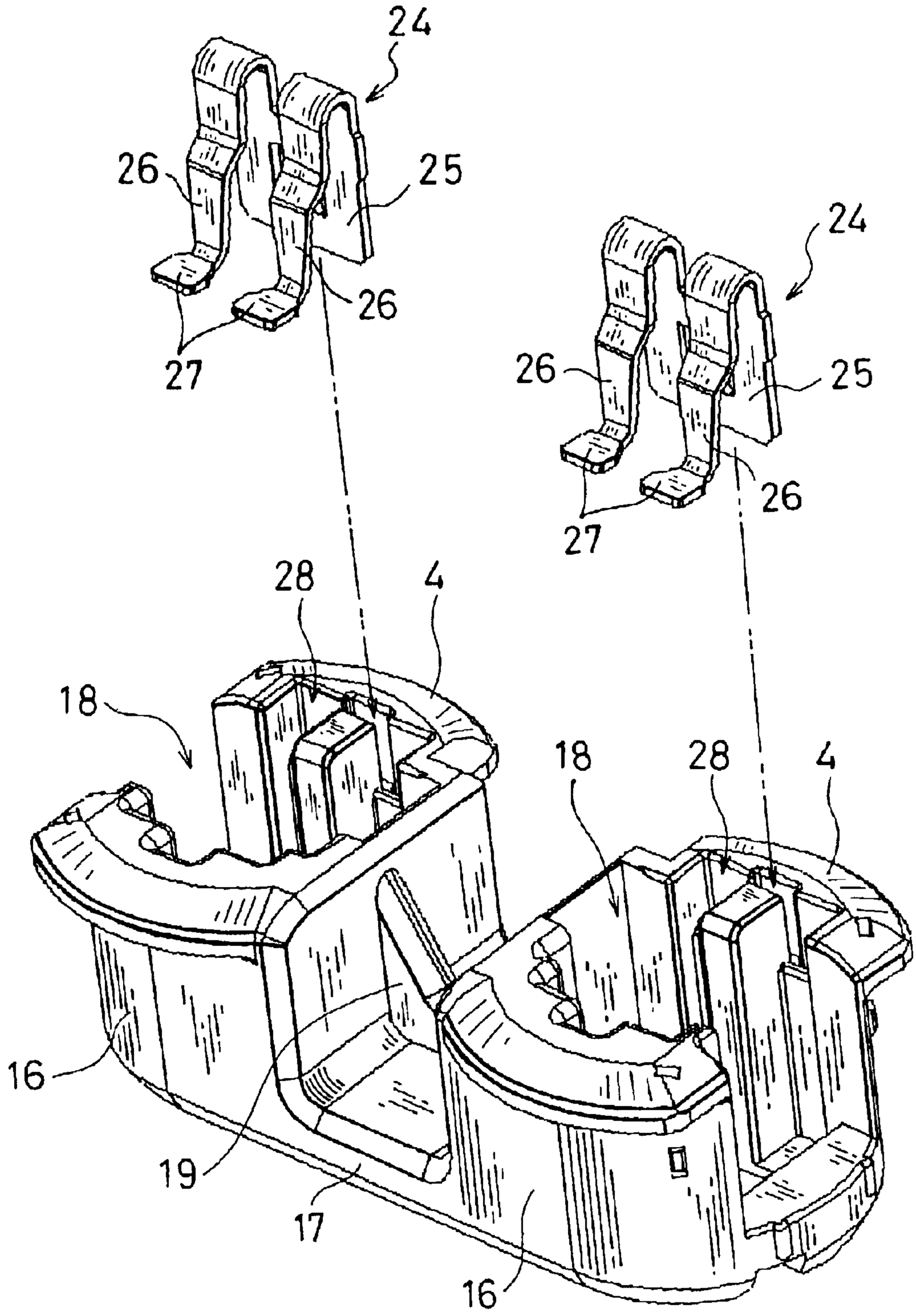

FIG. 5

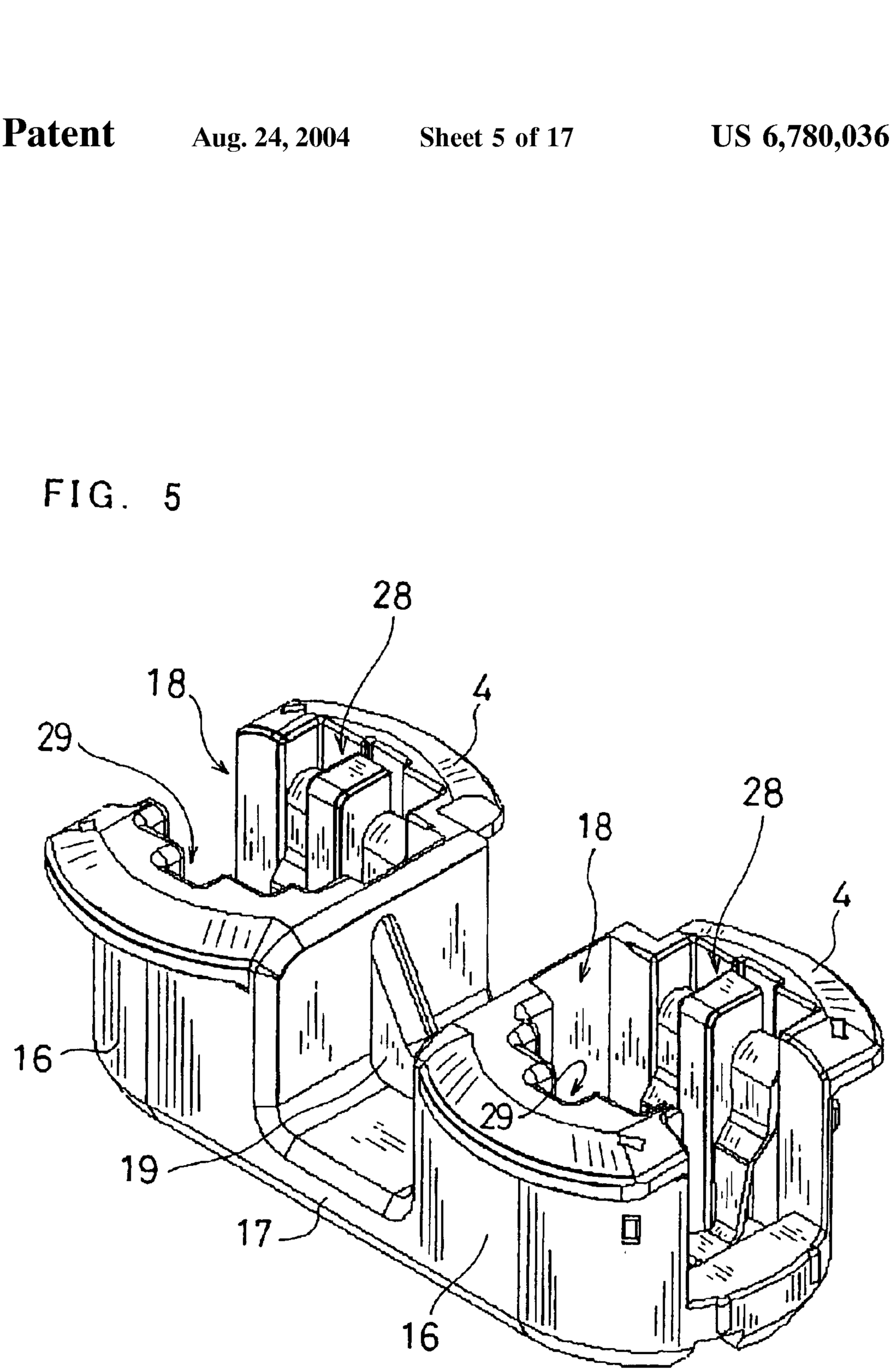

FIG. 6

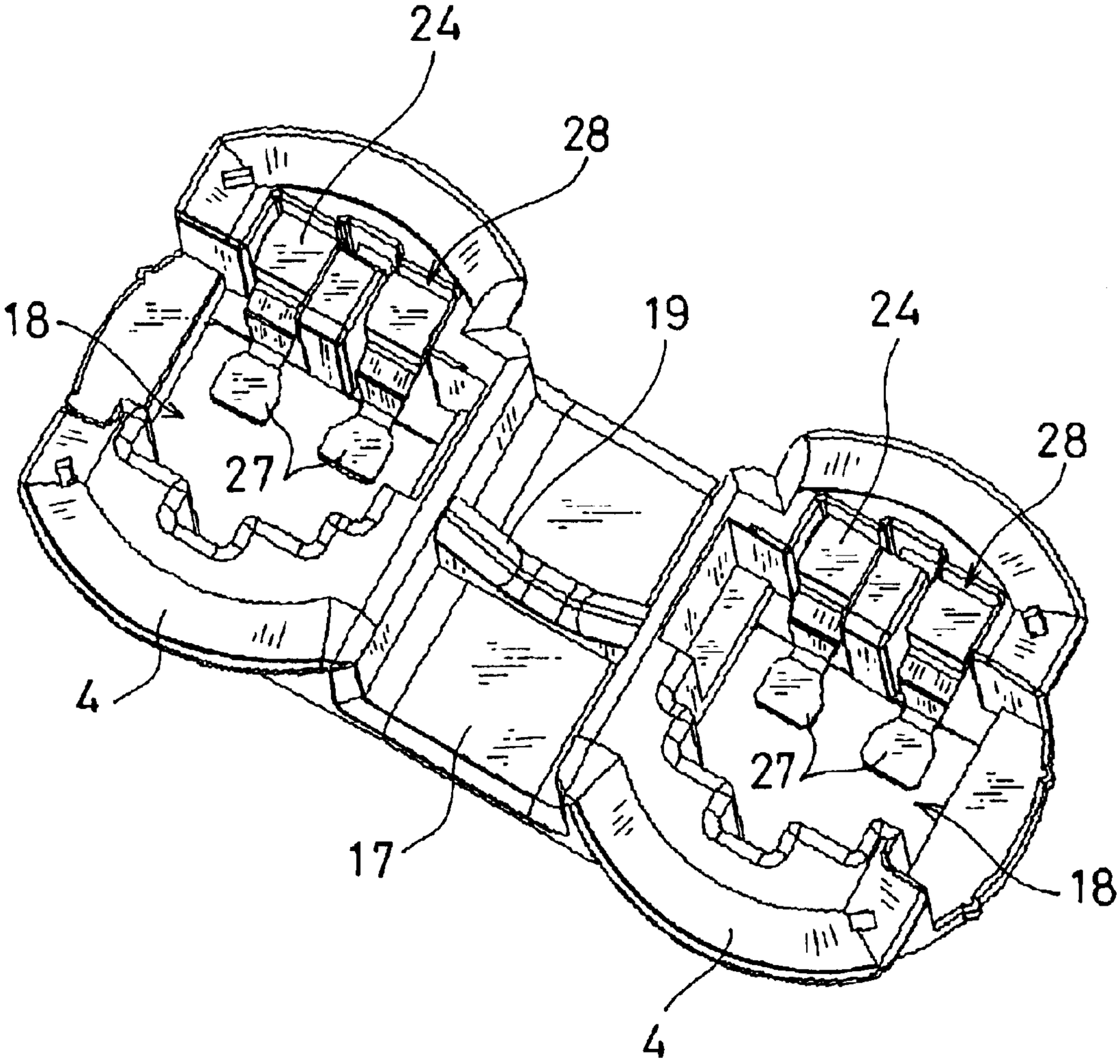

FIG. 7

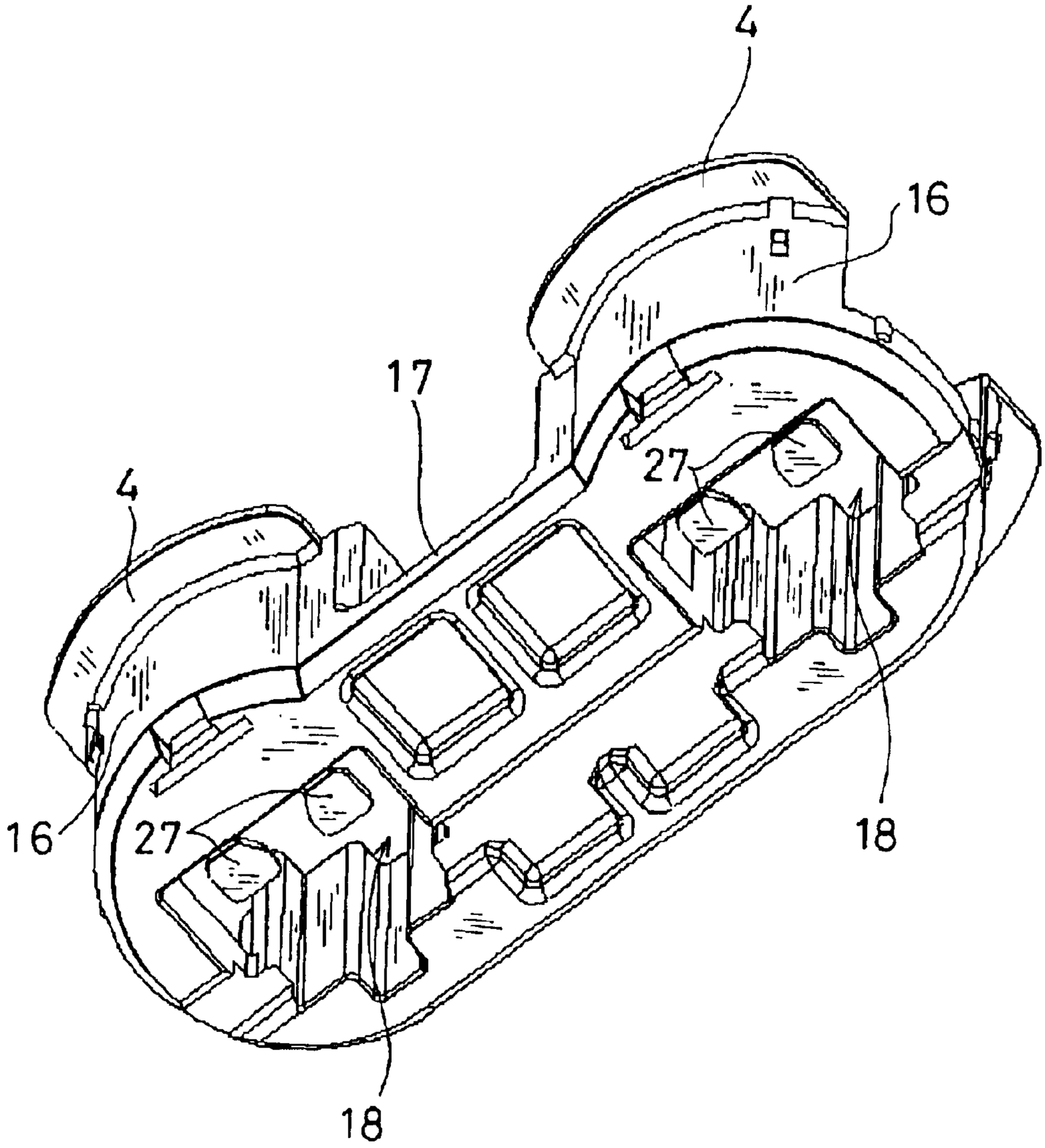

FIG. 8

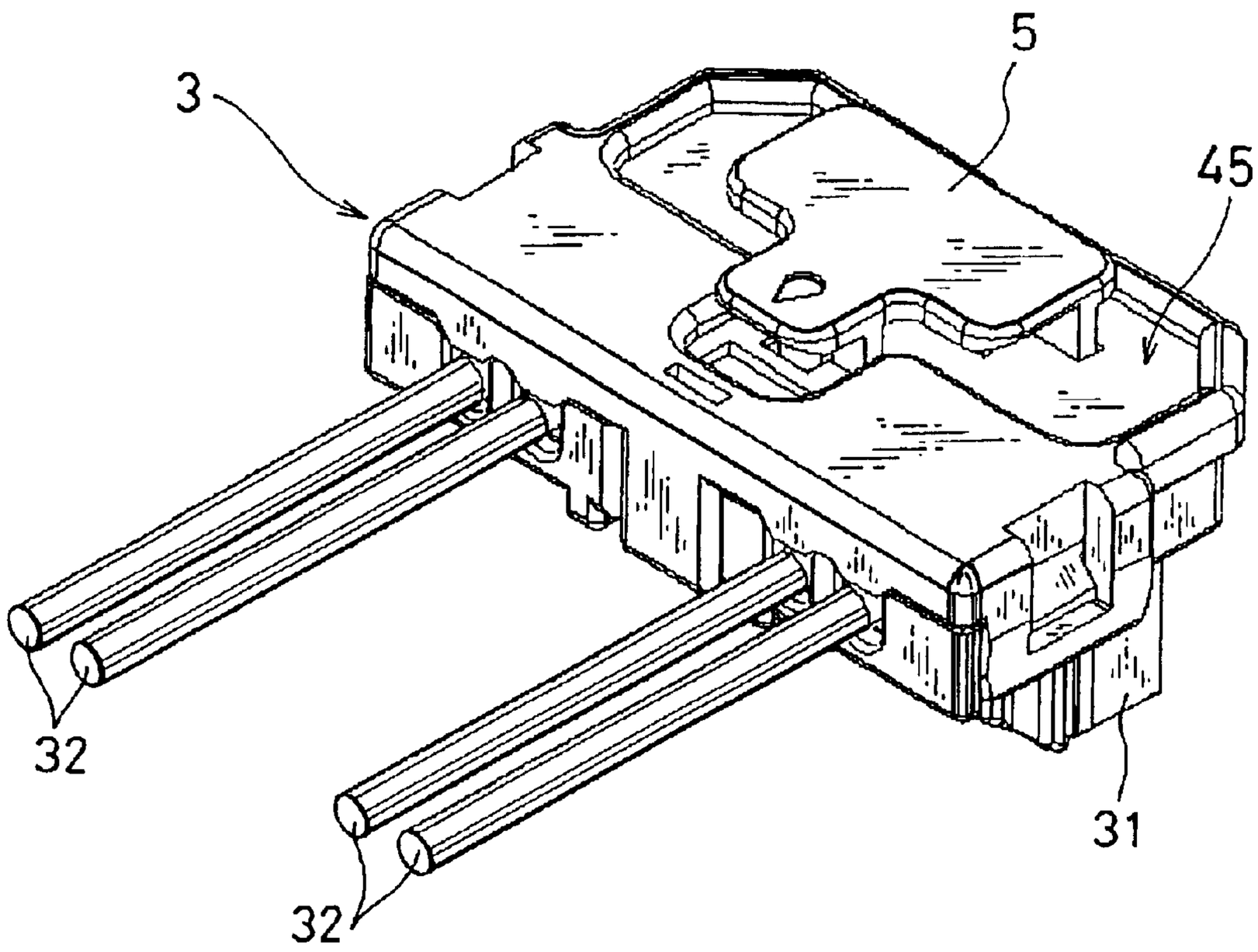

FIG. 9

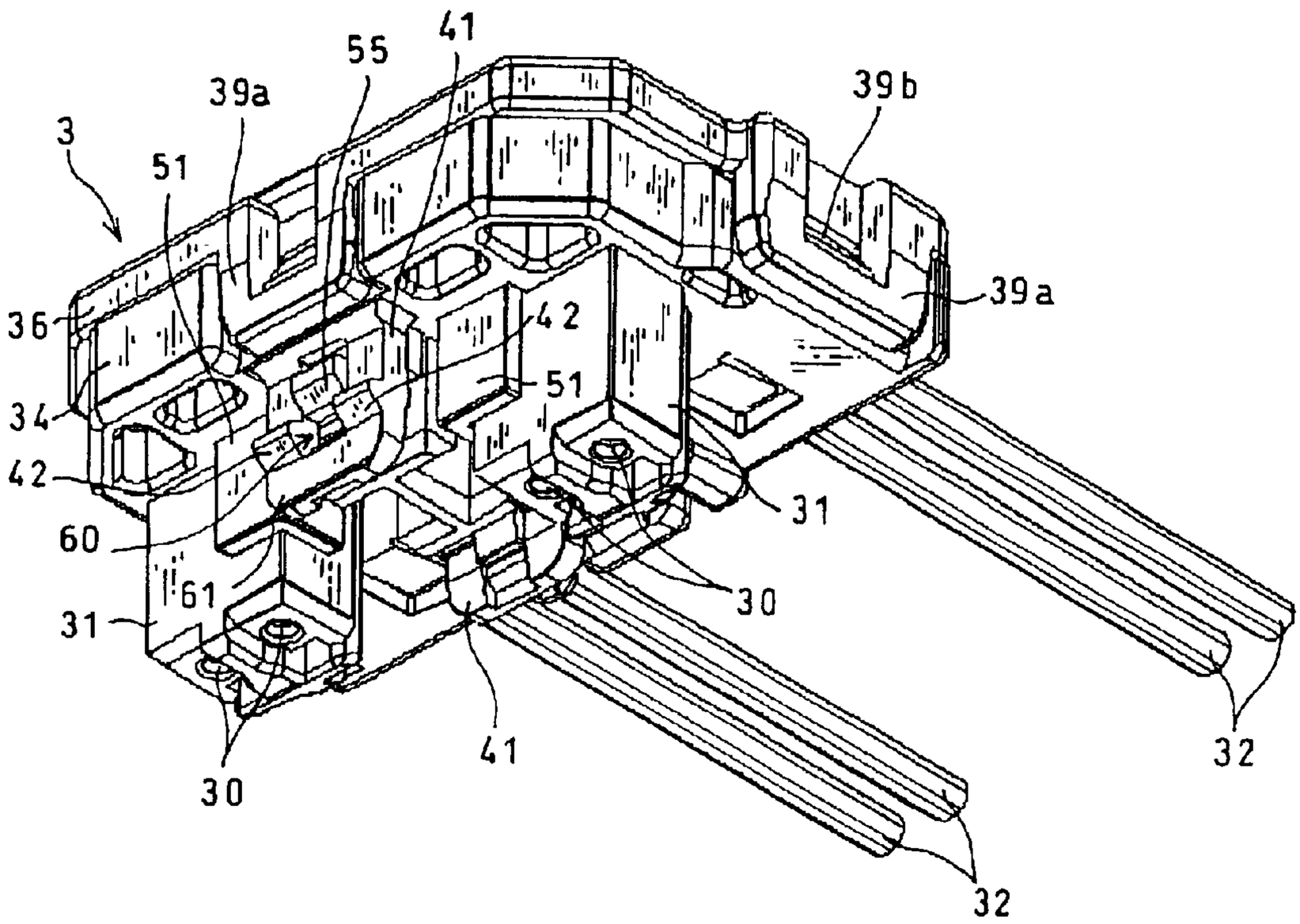

FIG. 10

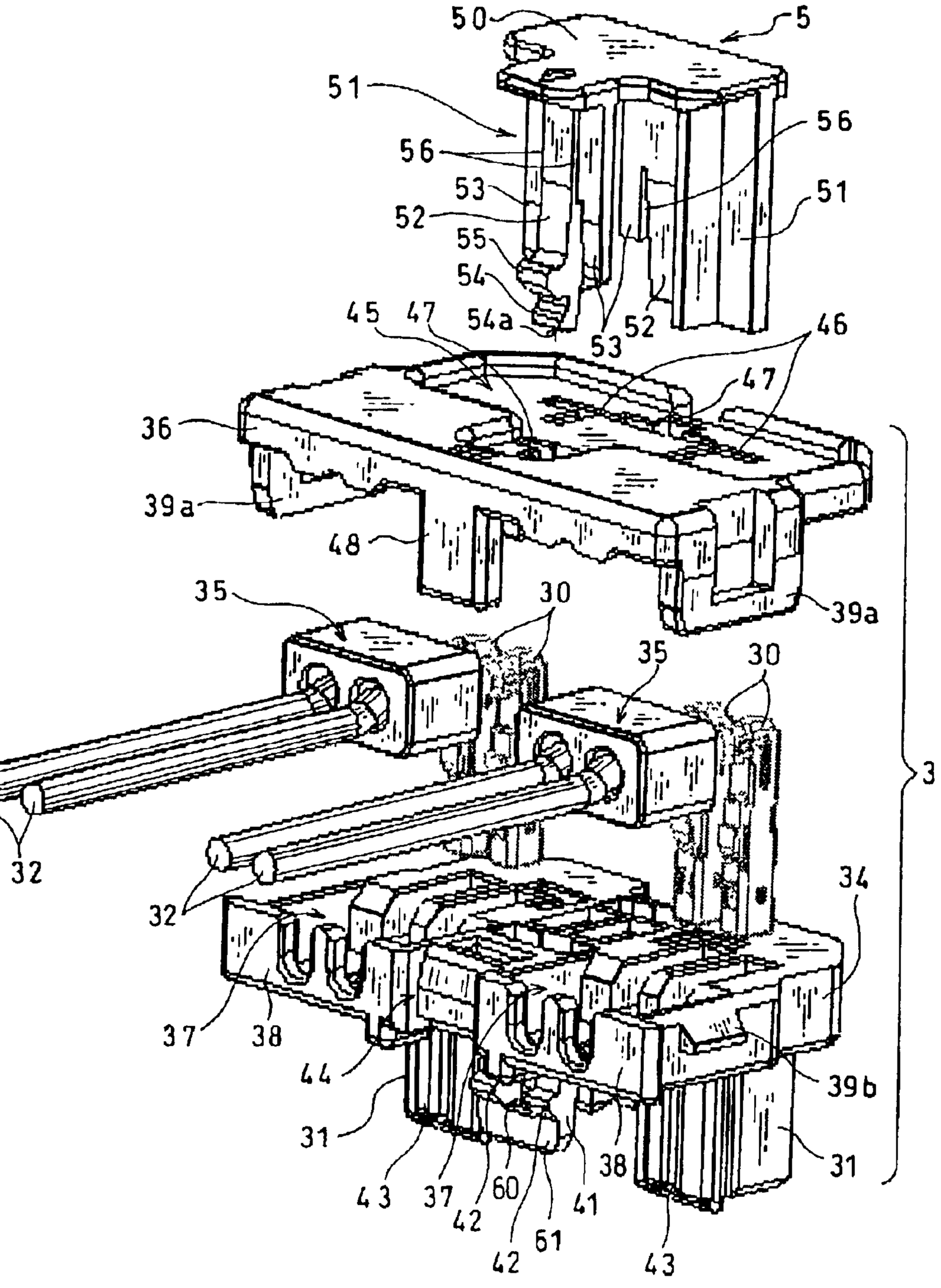
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FIG. 11

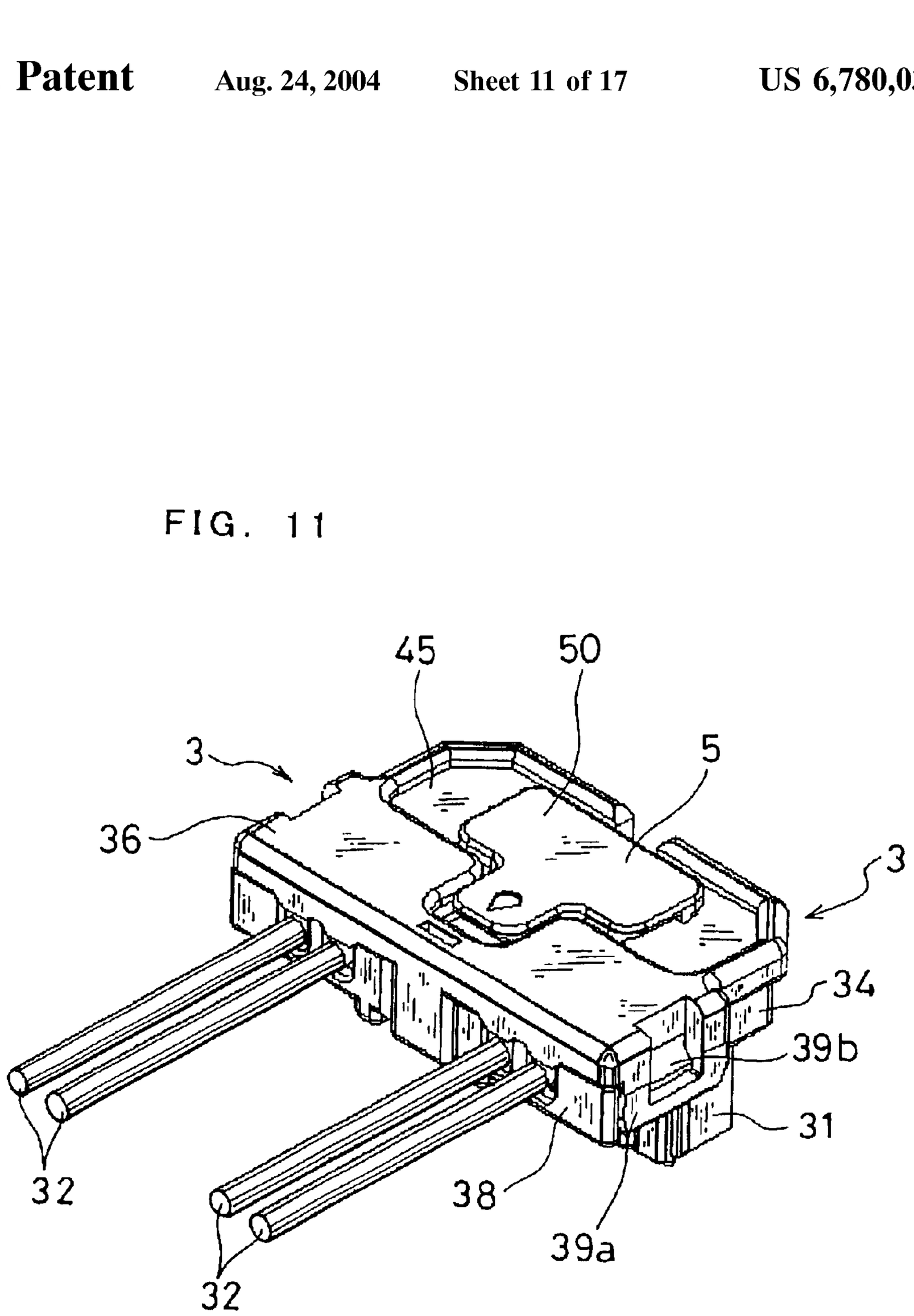

FIG. 12

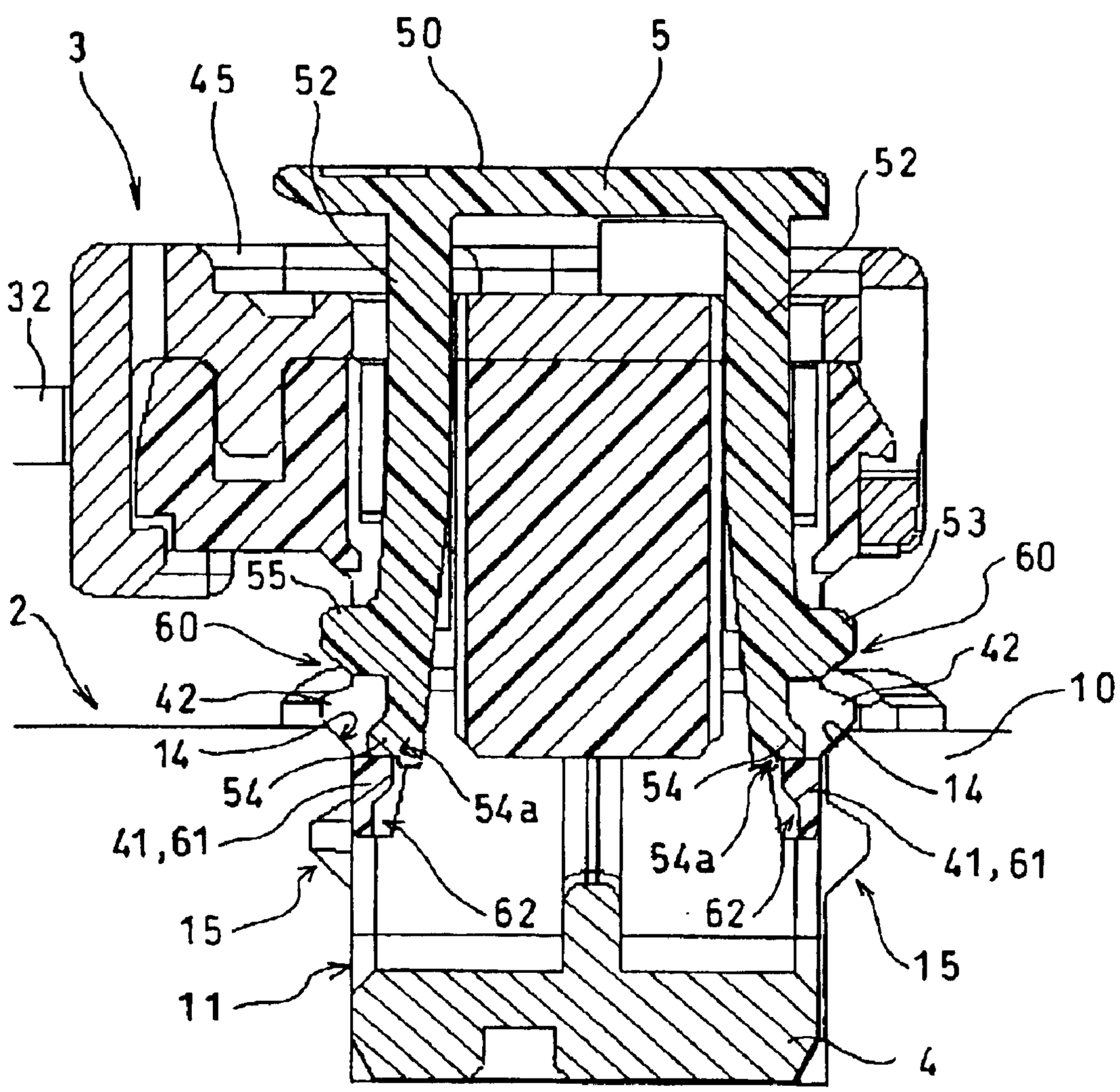
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FIG. 13

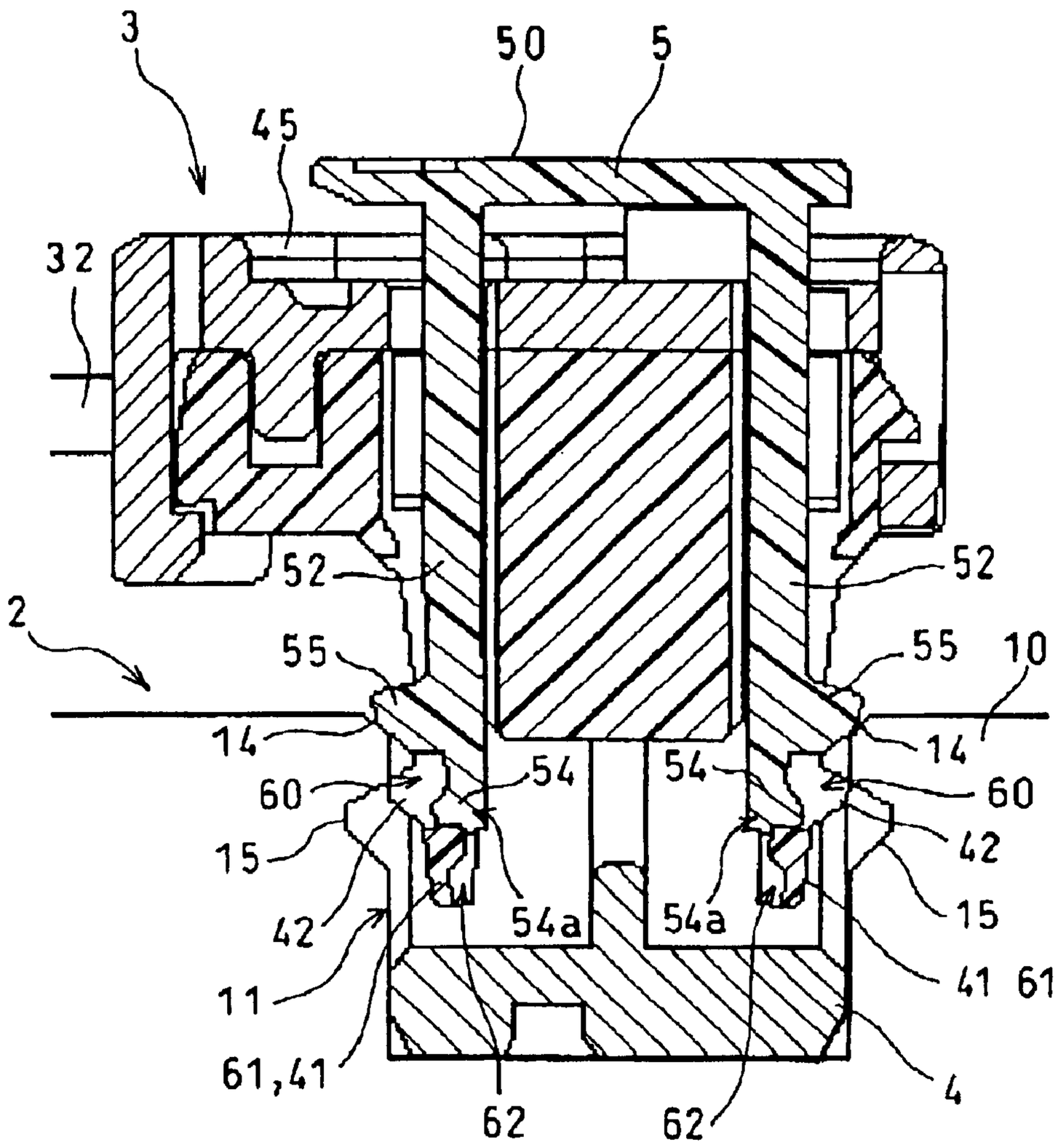
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FIG. 14

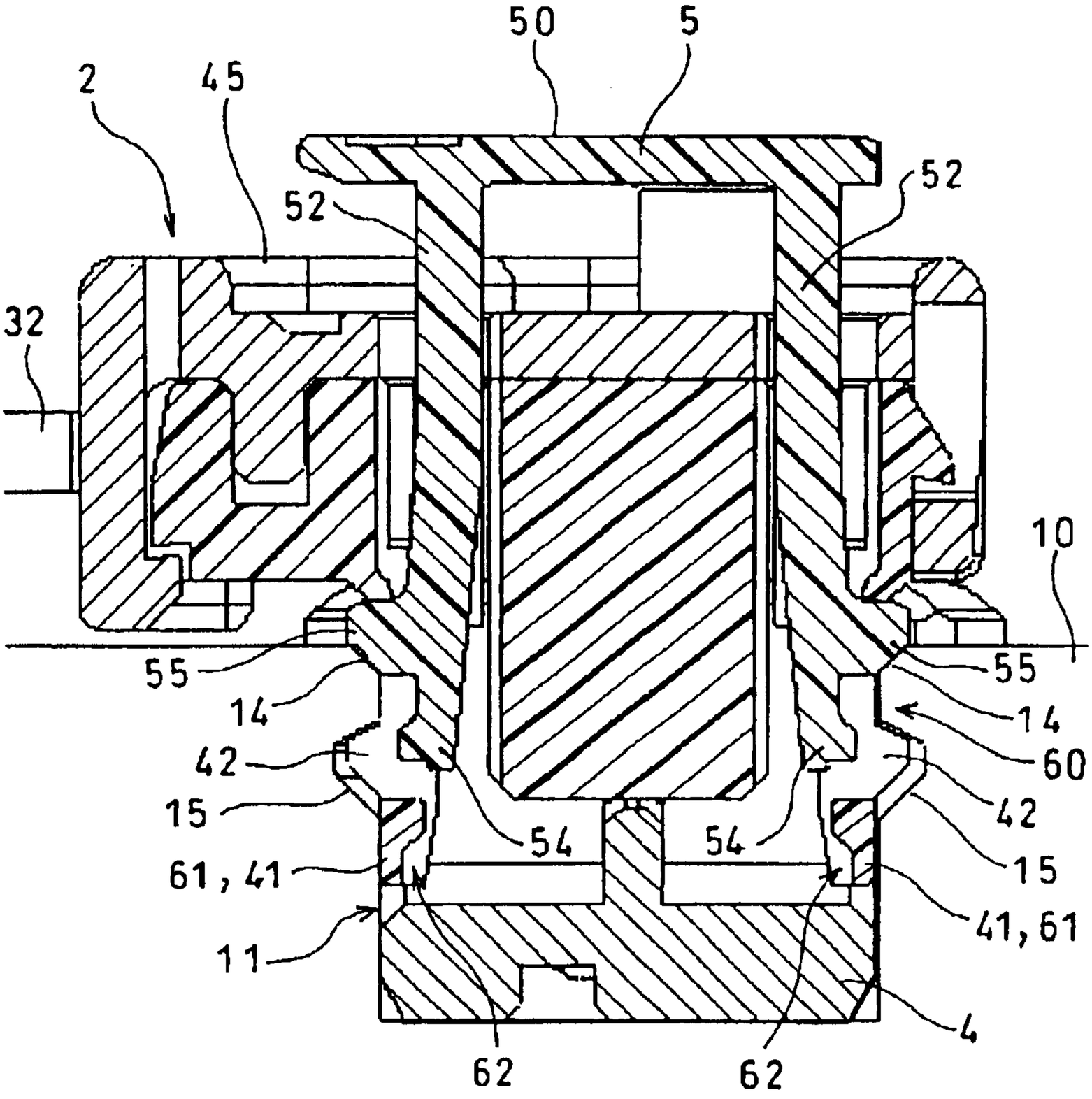
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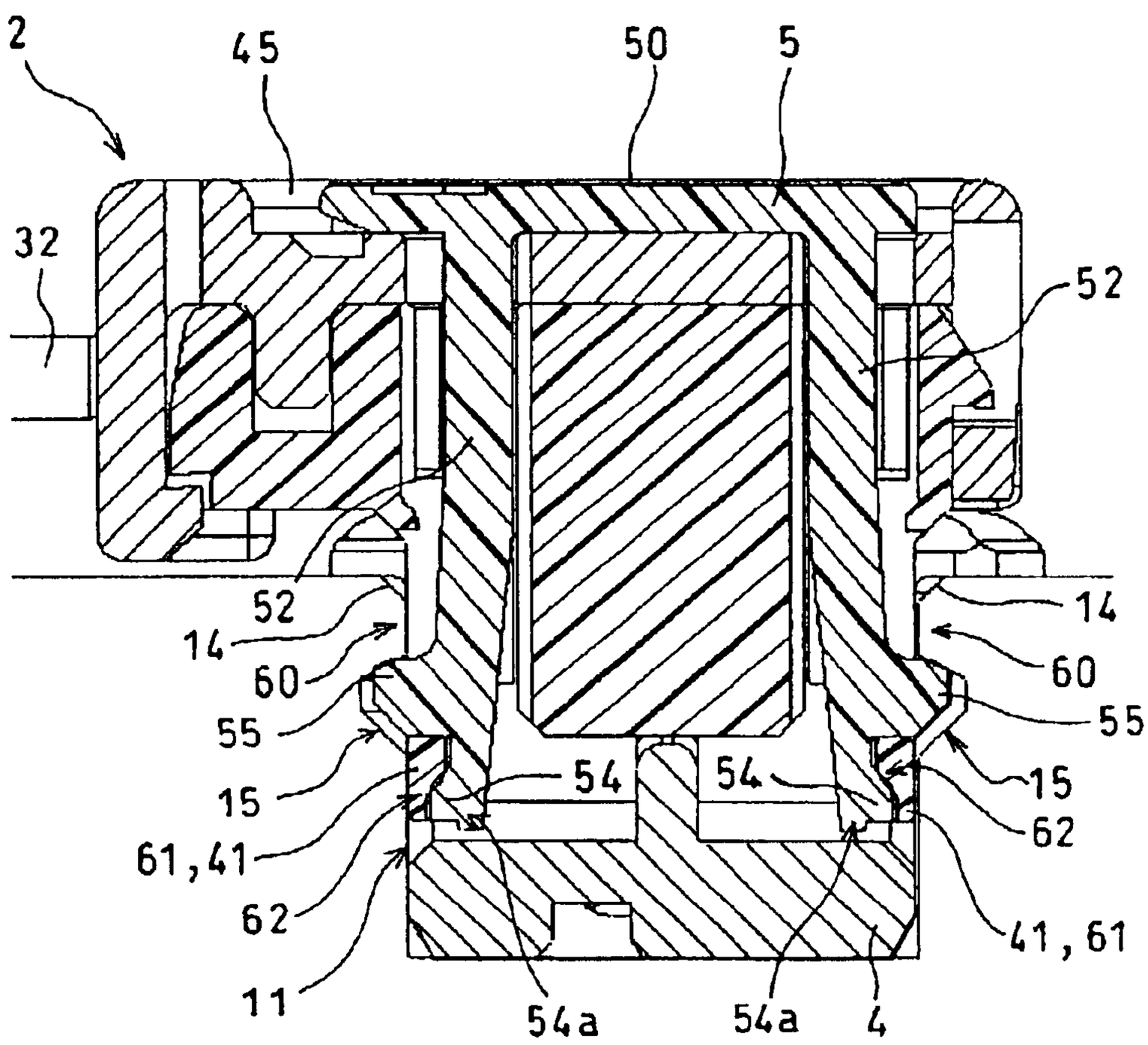
FIG. 15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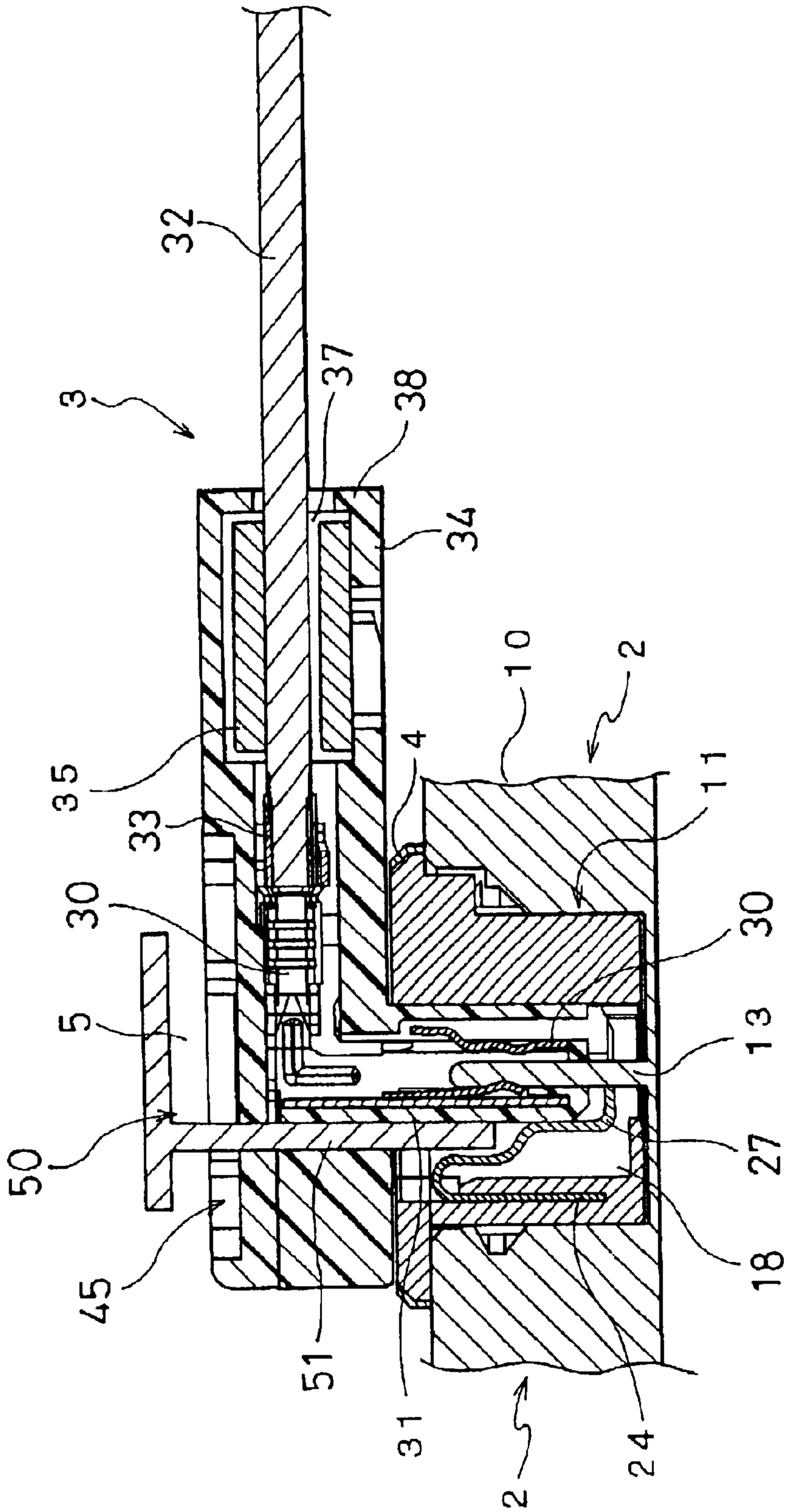

FIG. 16

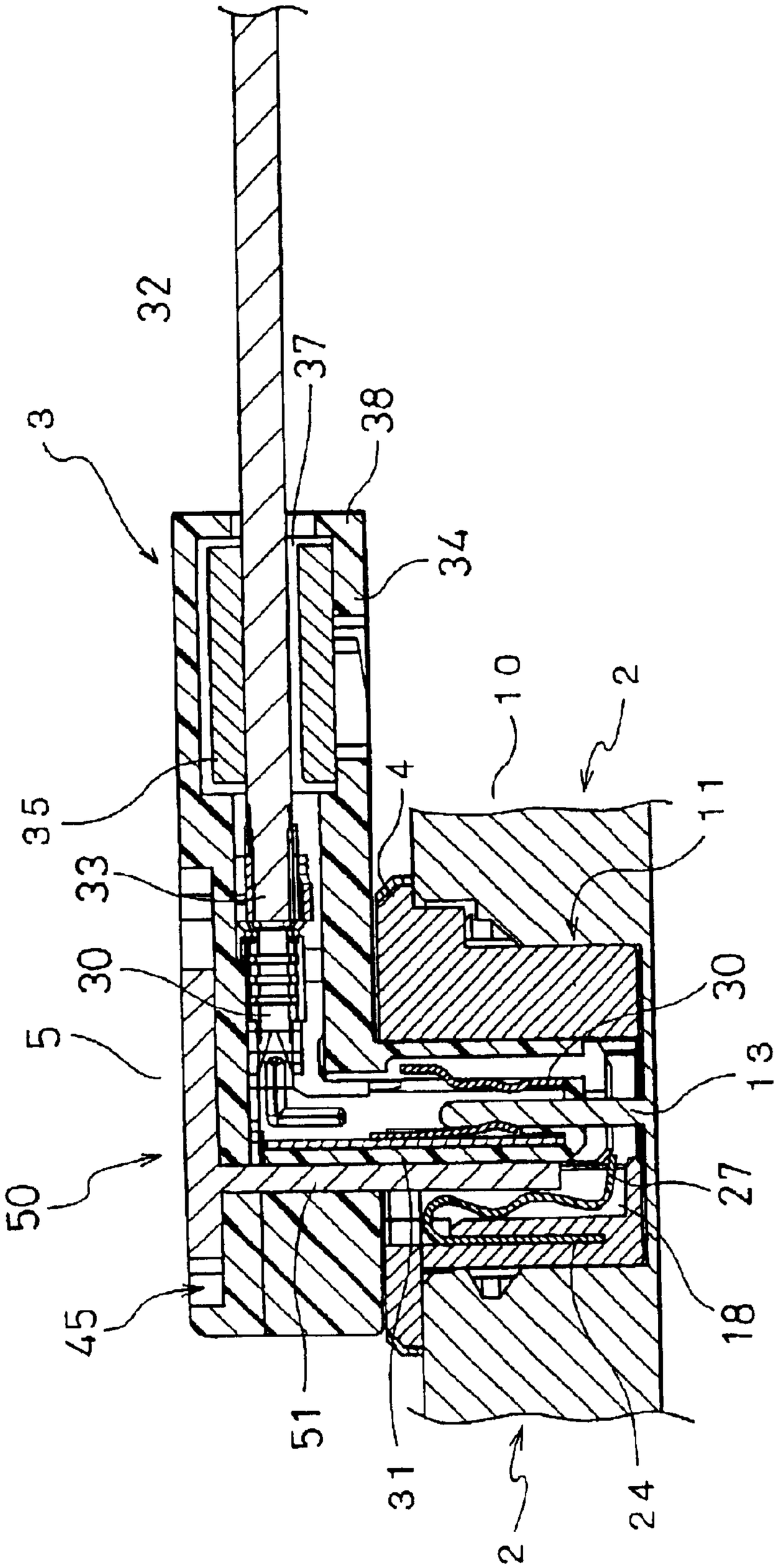

FIG. 17

ELECTRICAL CONNECTOR ASSEMBLY COMPRISING LOCKING PART

BACKGROUND OF THE INVENTION

1. Technical Field of the Invention

The present invention belongs in a technical field of an electrical connector assembly. Particularly, the present invention relates to an electrical connector assembly wherein a plug is provided with a locking element which permits electrical contact points of a socket to be short-circuited with each other when the socket and the plug are not adequately connected with each other and permits the short-circuit to be released when they are adequately connected with each other.

2. Description of the Prior Art

An airbag system comprises an airbag assembly and an electric or electronic control system which are assembled in a hidden compartment of a driver's cabin of a vehicle. The control system is connected with the airbag assembly via a wire harness. The wire harness is provided with a typical electrical plug and socket connector assembly, to allow a simple way for the airbag assembly and the control system to be electrically interconnected after assembled separately.

This connector assembly is provided with a so-called short-circuit clip. The short-circuit clip is a small metal element arranged in such a manner that the wires can be electrically short-circuited with each other within the plug or socket before the plug and the socket are engaged. The short-circuit clip is arranged as a safety device to prevent improper operation of the airbag assembly caused by leakage of electrical charge or improper connection in the course of production.

When the connector assembly is accurately connected, the safety device using the short-circuit clip for electrical short circuit must be shifted to a non-short-circuit position. U.S. Pat. No. 5,275,575 and JP Patent No. 2647336 disclose the electrical connector assembly with locking element which is so designed as to release the electrical short circuit provided by the safety device. This electrical connector assembly is so structured that it does not operate until the plug and the socket are both put in their completely engaged position and the locking element is shifted to its locked position. Also, the locking element serves to prevent the plug and the socket from being disconnected accidentally after combined.

The airbag systems using this electrical connector assembly take much account of inflation properties and like aspects of the airbag assembly. In view of this, some of the airbag systems in recent years have two igniters for each airbag, for energizing and igniting a gas generator to inflate the airbag. This type of airbag system requires two pairs of electrical contacts and it takes the formation that the two electrical connector assemblies are placed in proximity, as disclosed by JP Patent No. 2647336.

However, this type one requires a two-step motion for fitting the connector assemblies. It also requires that the connector assemblies be distinguished by using different colors or shapes, in order to prevent improper connection of those two connector assemblies. Further, it requires the confirmation of the fitting position of the connector assemblies. Also, because of working space limitations in the fitting position of the connector assemblies, the confirmation of the fitting position must be done with difficulty, thus presenting the problem with workability. In addition, Effective use of the connection space requires the work that the two sockets are placed in position while making a position adjustment to bring the electrical contacts of each pair into alignment in series in each of the sockets.

In the case of the electrical connector assembly described in JP Patent No. 2647336, for bringing the electrical connector assembly into the completely connected state, a two-step motion is required comprising the first step motion of engaging the plug and the socket with each other and the second step motion of inserting the locking element into the both components to its locked position. Also, the locking element is integrally mounted on either of the plug and the socket via a flexible arm. Because of this, the either of the plug and the socket is increased in size, thus making it hard to handle the electrical connector assembly.

SUMMARY OF THE INVENTION

It is the primary object of the present invention to provide an electrical connector assembly having a locking part that can provide an improved working efficiency and thus provide excellent connection workability even when two pairs of electrical contacts are connected with each other.

In accordance with one aspect of the invention, there is provided an electrical connector assembly comprising: (1) a socket for supporting two pairs of first electrical connector elements in proximity; (2) a plug for supporting two pairs of second electrical connector elements which are to be engaged with the two pairs of first electrical connector elements, respectively; (3) two short-circuit elements, fitted in the socket, for electrically short-circuit the two pairs of first electrical connector elements, respectively; and (4) a locking element which is locked at a first position with respect to the plug and, when the plug is engaged in the socket, becomes movable to a second position at which the locking element forces the two short-circuit elements to move back to their non-short-circuit positions simultaneously.

According to this construction, since the socket is constructed to support the two pairs of first electrical connector elements in proximity, the two sockets can be so arranged that the electrical contacts of each pair can be aligned in series. This can provide the result of facilitating the effective use of the connection space.

Also, since the plug is constructed to support the two pairs of second electrical connector elements as a unit, the double action commonly required for the engagement of the connector assembly can be reduced in half to the single operation.

Further, since the socket and the plug can be engaged with each other in only a limited orientation, the need to distinguish the two connector assemblies by using different colors or shapes for the purpose of preventing improper connection of the two connector assemblies is eliminated to begin with. In addition, the need to check the fitting positions of the connector assemblies is eliminated to begin with. Thus, in addition to reducing a component count, additional works, such as the color coding, and the checking work of the fitting positions can be cut.

Also, since the integrally formed locking element can allow the two short-circuit elements to move back to their non-short-circuit positions simultaneously, the release of short-circuit can be completed in only a single operation.

Thus, the present invention can provide an electrical connector assembly having a locking part that can provide a drastically improved working efficiency and thus provide excellent connection workability even when two pairs of electrical contacts are connected with each other.

These and other objects, features and advantages of the invention will become more apparent upon a reading of the following detailed specification with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a perspective view showing the entire structure of an electrical connector assembly according to an embodiment of the invention;

FIG. **2** is a perspective view of a socket and a short-circuit element of the electrical connector assembly according to the embodiment of the invention;

FIG. **3** is a perspective view of the socket of the electrical connector assembly according to the embodiment of the invention;

FIG. **4** is a perspective view of the short-circuit element of the electrical connector assembly according to the embodiment of the invention;

FIG. **5** is a perspective view of the short-circuit element of the electrical connector assembly according to the embodiment of the invention;

FIG. **6** is a perspective view of the short-circuit element of the electrical connector assembly according to the embodiment of the invention;

FIG. **7** is a perspective view of the short-circuit element of the electrical connector assembly according to the embodiment of the invention;

FIG. **8** is a perspective view of a plug of the electrical connector assembly according to the embodiment of the invention;

FIG. **9** is a perspective view of the plug of the electrical connector assembly according to the embodiment of the invention;

FIG. **10** is an exploded perspective view of the plug of the electrical connector assembly according to the embodiment of the invention;

FIG. **11** is a perspective view of the plug of the electrical connector assembly according to the embodiment of the invention;

FIG. **12** is a sectional view showing an initial engagement state of the plug into the socket of the electrical connector assembly according to the embodiment of the invention;

FIG. **13** is a sectional view showing an intermediate engagement state of the plug into the socket of the electrical connector assembly according to the embodiment of the invention;

FIG. **14** is a sectional view showing an intermediate engagement state of the plug into the socket of the electrical connector assembly according to the embodiment of the invention;

FIG. **15** is a sectional view showing a complete engagement state of the plug into the socket of the electrical connector assembly according to the embodiment of the invention;

FIG. **16**, which corresponds to FIG. **14**, is another sectional view showing the intermediate engagement state of the plug into the socket; and

FIG. **17**, which corresponds to FIG. **15**, is another sectional view showing the intermediate engagement state of the plug into the socket.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following, an embodiment of the present invention will be described. It is to be noted that only a certain preferred embodiment of the present invention is shown for convenience of explanation and is not to be construed as limiting the present invention.

The present invention is particularly suitably applicable to an airbag system for restraining vehicle occupants and, accordingly, the application to the airbag system is illustrated here as an example of the preferred embodiments of the present invention. It is to be understood, however, that the present invention is applicable within a wider range for various different environments and various intended objects, without limiting to the application to the airbag system.

Referring to the accompanying drawings, there is shown in FIG. **1** the entire structure of a connector assembly or an electrical connector assembly **1** used with the airbag system. In this diagram, the connector assembly **1** comprising a plug **3** engageable with a socket **2** is shown in the engaged state.

The socket **2** is provided in the form of a part of an airbag igniter (which is sometimes referred to as a squib) to be electrically connected to an airbag system control system. There are provided two igniters, though their body portions are not shown in FIG. **1**. The igniter is an explosive device which is burnt when sufficient electric energy is applied to it through two conducting wires **32** of each pair. The burning of the igniter triggers the gas generating material to be ignited and, as a result of this, the airbag is inflated.

FIG. **2** shows the socket **2** which is in the state in which the plug **3** is disengaged from the electrical connector assembly **1**. Two, integrally molded, short-circuit elements **4** are fitted in the socket **2** with a press-fit. The short-circuit elements **4** put contacts of the socket **2** into the short-circuited state until the socket **2** and the plug **3** are mechanically and electrically connected with each other.

FIG. **8** shows the plug **3** electrically connected with the control system. The plug **3** is to be engaged in the socket **2**. A locking element **5** is held in the plug **3** in its locked state in the first locking position shown in the diagram (hereinafter it is simply referred to as "the first position").

The functions and mutual relations of these various components will be clarified from the following description. As will be obvious from the following description, the plug **3**, the short-circuit elements **4** and the locking element **5** are preferably formed of proper non-conductive plastic material, except various kinds of wires and contacts.

Referring first to the socket **2**, the socket **2** is formed to have a cylindrical body **10** forming therein an accommodating portion **11** of a slot-like form for accommodating the two short-circuit elements **4**. This socket **2** is well shown in FIGS. **1–3**, in particular. The body **10** forming the accommodating portion **11** therein can be directly built in its related structure such as an igniter housing. Further, the accommodating portion **11** may be formed as a separate element so that it may be added to its related structure. In either configuration, the body **10** forming the accommodating portion **11** therein terminates at a bottom wall **12**, as best shown in FIG. **3**. Extended from the bottom wall **12** are two pairs of first conductive male electrical connector elements or pins **13** formed of metal. The socket **2** serves to support the two pairs of pins **13** in proximity so that the two pairs of pins, two for each pair, can all be arranged in series. These two pairs of pins **13** are connected to their respective conducting wires of two airbag igniters (not shown) in any conventional manner. The igniters are electrically energized through these pins **13** so that they can be ignited. As well shown in FIG. **3**, the accommodating portion **11** of slot-like form is formed to have such a configuration that its outer circumferential part is partly folded inside at only one side

of the part extending in the direction of the major axis of the slot. Also, the plug **3** is made to have the configuration and dimension corresponding to those of the outer circumferential part of the accommodating part **11**, so as to prevent inadequate engagement between the socket **2** and the plug **3**.

The accommodating part **11** has an inclined surface **14** formed at an entrance thereof. Also, the accommodating part **11** has a locking recess **15** formed in its inner surface to extend continuously in the circumferential direction. This configuration is well shown in FIGS. **12–15**, for example. These figures show the electrical connector assembly **1** in section taken along line extending in parallel with the conducting wires **32** lying in the middle of the space between the two pairs of conducting wires **32**. As will be understood well from these figures, the inclined surface **14** serves to receive locking portions **42** provided at elastic legs **41** of the plug **3**, as mentioned later, and produce a deforming moment to move the locking portions **42** toward the center (See FIGS. **12**, **13**). Further, the inclined surface **14** serves to receive second locking portions **55** of the locking element **5**, as mentioned later, and produce a deforming moment to move the second locking portions **55** toward the center (See FIG. **14**). The locking recess **15** serves to receive the locking portions **42** of the plug **3** and keep it in its engaged state, as best shown in FIG. **14**. Also, the locking recess **15** serves to receive the second locking portions **55** of the locking element **5** and switch the locking element **5** to the second locking position (hereinafter it is simply referred to as "the second position"), as best shown in FIG. **15**.

Referring second to the two short-circuit elements **4**, the two short-circuit elements **4** are received in the accommodating portion **11**, to be engaged with the plug **3**. During the time during which the locking element **5** of the plug **3** does not assume the second position, the electrical connection is provided. Thus, the two short-circuit elements **4** serve to short-circuit the two pairs of pins **13** of the first male electrical connector elements.

As well shown in FIGS. **2** and **4–7**, each of the two short-circuit elements **4** has a plastic body **16** of a generally cylindrical shape having a dimension to tightly fit and supported in the accommodating portion **11**. The two short-circuit elements **4** are formed in one piece, such that they are continuously connected with each other via a bridge portion **17**. The bridge portion **17** is provided with a reinforcing rib **19**. The two short-circuit elements **4** have in their bodies **16** two openings **18**, respectively, to receive the plug bodies **31** for supporting the two electrical terminals **30** of each pair which are the second male electrical connector elements of the plug **3** mentioned later. The two pairs of pins **13** are also extended passing through these two openings **18**. The two openings **18** are formed to open to tops thereof and lateral sides thereof opposite to the side on which the bodies **16** are connected with each other via the bridge portion **17**, respectively.

The two short-circuit elements **4** have short-circuit clips **24**, respectively. FIG. **4** shows the state of the short-circuit clips **24** before being inserted into the related short-circuit elements **4**. FIG. **5** shows the state of the short-circuit clips **24** after being inserted into the related short-circuit elements **4**. FIGS. **6** and **7** show the short-circuit elements **4** as viewed from the top and bottom thereof, respectively. As well shown in these figures, the short-circuit clips **24** are held in the bodies **16** of the two short-circuit elements **4**, respectively. The short-circuit clips **24** are formed of conductive material having elasticity such as spring steel. The short-circuit clips **24** are partly deflected to the direction of their abutting with the both pins **13**. The abutment of the short-circuit clips **24** with the pins **13** provides an electrical short-circuit therebetween.

As best shown in FIG. **4**, each of the two short-circuit clips **24** comprises a plate-form base **25**, a pair of legs **26** folded back at the top of the base **25** and extending downward therefrom and a pair of abutting portions **27** folded at an angle of 90 degree at the lower portions of the pair of legs **26**. Each of the legs **26** is folded and deflected stepwise in the direction of its being away from the base **25**. The abutting portions **27** of the short-circuit clips **24** are brought into abutment with lateral sides of the pins **13** located at the corresponding positions, to electrically connected therewith. As will be well understood from FIGS. **5** and **6**, the short-circuit clips **24** are held in the bodies **16** of the short-circuit elements **4**, with their bases **25** inserted in slit-like recesses **28** of the short-circuit elements **4** so as not to slip off.

FIGS. **16** and **17** show the electrical connector assembly **1** in section taken along any plane including the conducting wire **32** and the pin **13**. These figures show the short-circuit element **4** accommodated in the accommodating portion **11** and the pin **13** extending upwardly within the opening **18**. FIG. **16** shows the state in which the pin **3** is in abutment with the abutting portion **27** of the short-circuit clip **24** and thus is in electrical connection with it. FIG. **17** shows the state wherein legs **26** of the short-circuit clips **24** are bent by plugging the locking element **5** mentioned later and thereby the electrical connection between the abutting portion **27** of the short-circuit clip **24** and the pin **13** is released.

Referring third to the plug **3**, the structure of the plug **3** will be better understood from FIGS. **8–10** and **16**. FIG. **8** is a perspective view of the plug **3** as viewed from the top; FIG. **9** is a perspective view of the plug **3** as viewed from the bottom; and FIG. **10** is an exploded perspective view of the plug **3**. As shown in these figures, the plug **3** includes a plug body portion **31** extending downwardly and supporting two pairs of electrical terminals **30**, two electrical terminals for each pair, which are in the form of second female electrical connector elements. These two pairs of electrical terminals **30** are electrically connected with the two pairs of conducting wires **32**. Also, these two pairs of electrical terminals **30** are engaged with the two pairs of pins **13** or first male electrical connector elements, respectively, so as to be electrically connected therewith. Each pair of electrical terminals **30** are supported as a unit by the plug **3**. Also, the electrical terminals **30** are formed to have configuration and size to receive the pins **13** therein and are mounted to extend in parallel with each other.

As well shown in FIGS. **10** and **16**, the two electrical terminals **30** of each pair built in the central plug portion **31** each have a conducting wire connecting portion **33** for connecting one of the conducting wires **32**. The conducting wire connecting portions **33** are provided in the electrical terminals **30** at their portions which extend from the tubular terminal portions forming the second female connector element and change in direction in a generally L-form. The conducting wires **32** are the insulation armored wires. Insulating coatings of the conducting wires **32** are peeled at the ends thereof so as to be electrically and mechanically attached to the conducting wire connecting portion **33** to which the conducting wires are connected. The attachment of the wires is usually performed by press-fitting a part of the conducting wire connecting portions **33** around the bare wires at the ends thereof in any conventional manner. The two pairs of conducting wires **32** pass through ferrite beads **35** placed in a box-shaped room **37** formed at a lower portion **34** of the plug **3**. The bead **35** is a generally box-shaped homogeneous substance used for providing the noise filtering out function. Each bead **35** has two tubular thru holes

extending in parallel with each other, through which the conducting wires **32** pass. The conducting wires **32** are extended out from an end of the lower portion **34**, passing through an opening of a rear wall **38** of the room **37**.

The lower portion **34** of the plug **3** is provided, at a bottom side thereof, with two plug bodies **31** of a generally square cylinder shape and two elastic legs **41**. The two elastic legs **41** are disposed between the two plug bodies **31**, such that a generally cross-shape is formed by a line connecting between the two elastic legs **41** and a line connecting between the two plug bodies **31**. The two elastic legs **41** have, on their outside surfaces, locking portions **42** to be engaged in the locking recess **15** formed in the inside of the accommodating portion **11**, as previously mentioned, and the locking portions **42** are formed by outwardly protruding lugs (See FIGS. **9**, **10** and **11**). The locking portions **42** are so located and sized as to be fitted in the locking recess **15** when the plug **2** is adequately engaged with the socket **2**.

The two plug bodies **31** are so located and sized as to provide frames having enough rigidity for the plug **3** to be disposed in the accommodating portion **11** formed in the socket **2**. As shown in FIG. **10**, the plug bodies **31** have ridges **43**. The ridges **43** are so sized and located as to be engaged with recesses **29**, as shown in FIGS. **2** and **5**. The engagement between the ridges **43** and the recesses **29** ensures the correct connection between the electrical terminals **30** of the plug **3** and the pins **13** of the socket **2**.

As best shown in FIG. **10**, the plug **3** further has an upper portion **36** that covers end portions of the conducting wires **32** and the beads **35** and engages with the lower portion **34**. The upper portion **36** and the lower portion **34** are combined into a general rectangular parallelepiped shape by engagement of a pair of locking portions **39***a*, **39***b* which are provided in two opposite side surfaces of the upper and lower portions, respectively. The upper portion **36** and the lower portion **34** are locked in their properly engaged state by the engagement between the pair of locking portions **39***a*, **39***b*. The upper portion **36** has downwardly extending projections **48** which are so sized and located as to fit in concave portions **44** formed in the side surfaces of the lower portion **34**. The projections **48** subserve to position the upper portion **36** with respect to the lower portion **34**.

As well shown in FIGS. **8** and **10**, the upper portion **36** of the plug **3** has a wide shallow recess **45** formed in an upper surface thereof at a corresponding location over the plug bodies **31**. A pair of first perforated openings **46**, which are arranged opposite to each other in a generally L-shape with respect to the sides of the plug bodies **31**, are formed in the recess **45** at both widthwise sides thereof. A pair of second perforated openings **47**, which are arranged opposite to each other in a generally T-shape, such that a generally cross-shape is formed by a line connecting between the pair of first perforated openings **46** and a line connecting between the pair of second perforated openings **47**, are formed in the recess **45** at both lengthwise sides thereof. When the related portions of the locking element **5** are inserted in these perforated openings **46**, **47**, the locking element **5** is supported by the central plug portions **31**. The locking element **5** is locked at the first position. This locking will be further mentioned later.

Finally, reference is given to the structure of the locking element **5**. In FIG. **10**, the locking element **5** includes a head portion or pressing portion **50**, a pair of first legs **51** extending substantially in parallel with each other and a pair of second legs **52** extending substantially in parallel with each other. The pair of first legs **51** are formed to extend downwardly from both widthwise sides of the pressing portion **50**. The pair of first legs **51** each have a cross section of a generally inverted L-shape. The pair of first legs **51** serve to release the short circuits between the two pairs of first electrical connecter elements **13** when the plug **3** and the socket **2** are engaged with each other. The locking element **5** is inserted in the plug **3**, with their inverted L-shaped legs fitted in the pair of perforated openings **46**, respectively (See FIG. **8**). The pair of first legs **51** are so sized and located as to allow two sides of each of the inverted L-shaped legs to be inserted along two sides of each of the plug bodies **31**.

In FIG. **10**, the pair of second legs **52** are arranged at such locations that a generally cross-shape is formed by a line connecting between the pair of first legs **51** and a line connecting between the pair of second legs **52** and are formed to extend downwardly, respectively. The pair of second legs **52** have the locking portions formed to project outwardly. The locking portions each have a first locking portion **54** and a second locking portion **55** which are vertically arranged in the ascending order. The first locking portion **54** is formed to project outwardly to a small extent and the second locking portion **55** is formed to project outwardly to a large extent. The first locking portion **54** has, at its front end, a step portion **54***a* (See FIG. **12**). The provision of the first locking portion **54** enables the locking element **5** to be locked at the first position with respect to the plug **3** and the socket **2**, and the provision of the second locking portion **55** enables the locking element **5** to be locked at the second position with respect to the plug **3** and the socket **2**. The pair of second legs **52** each have two restraint portions **53** which are formed at both lateral sides thereof to extend downwardly in parallel with each other.

FIGS. **12–15** show the electrical connecter assembly **1** in section taken along the plane including the pair of second legs **52** of the locking element **5**. As will be well understood from FIGS. **9**, **10** and **12** of these figures, step portions **61** are formed at lower end portions of openings **60** of the elastic legs **41** of the plug **3**. When the locking element **5** is pressed in the plug **3**, the step portions **54***a* of the second legs **52** are brought into abutment with the step portions **61** of the elastic legs **41** and thereby are put into the locked state at the first position. At this time, the second locking portions **55** of the locking element **5** come to project outwardly from the opening **60** and thus are put in the operable state. The elastic legs **41** each have an inwardly hollowed locking recess **62** formed in its interior at the lower end portion thereof. When an outward projecting portion of the first locking portion **54** of the locking element **5** shifted from the first position is engaged in the locking recess **62**, the locking element **5** is locked in the second position. The locking element **5** is locked in the second position to an extent that can permit the locking element **5** to be restored to the first position when it is pulled up from the plug **3**.

As well shown in FIG. **10**, the restraint portions **53** at both lateral sides of the second legs **52** are spaced from the second legs **52** via the slits **56**, so as not to hinder the elastic deformation of the second legs **52**. Also, the restraint portions **53** are tapered so that their thicknesses are gradually decreased toward the lower ends. When the locking element **5** is inserted in the plug **3**, the restraint portions **53** are placed on the inside of the elastic legs **41**, respectively. When the locking element **5** is in the locked position of the first position, the deformation of the elastic legs **41** toward the inside of the locking portions **42** is not restrained by the restraint portions **53**. On the other hand, when the locking element **5** is shifted to the second position, the restraint portions **53** are placed in position with their thicknesses

decreased. This provides the result that when the locking portions **42** are made to disengage from the locking recess **15**, they comes into abutment with the restraint portions **53**, so that the locking portions **42** are prevented from being disengaged from the locking recess **15**. However, in the normal, space is left between the restraint portions **53** and the elastic legs **41**, and as such can ensure that the locking element **5** is smoothly shifted from the first position to the second position.

The locking element **5** thus constructed can be allowed to be locked in the first position with respect to the plug **3** and also can be allowed to be shifted to the second position where the two short-circuit clips **24** of the two short-circuit elements **4** are simultaneously moved back to their non-short-circuit positions when the plug **3** is engaged with the socket **2**. This action of the short-circuit clips **24** moving back to their non-short-circuit positions will be well understood from FIGS. **16** and **17**. Specifically, the locking element **5**, when pressed in from the first position to the second position, allows the first legs **51** to be advanced up to the folded portions of the short-circuit clips **24**, and as such can allow the abutting portions **27** to move away from the pins **13** to release the electrical short-circuit connection with the pins **13**. Thus, the locking element **5** can allow the socket **2** and the plug **3** to be engaged with each other in such a manner as to prevent them from being separated from each other; can allow them to be electrically connected with each other; and can further allow the short circulation provided by the two short-circuit elements **4** to be released simultaneously. As a result of this, the structure of the electrical connector assembly having these characteristic features can be realized with ease.

Now, connecting operation of the electrical connector assembly **1** described above will be described with reference to FIGS. **1**, **2**, **8** and **11–17**. As shown in FIG. **2**, the two short-circuit elements **4** are previously fitted in the accommodating portion **11** of the socket **2** to short-circuit the two pairs of pins **13**. On the other hand, as well understood from FIGS. **8** and **12**, the locking element **5** is previously locked in the first position with respect to the plug **3** or is previously locked, with the first locking portions **54** abutted with the step portions **61**. At this time, as shown in FIG. **8**, the head portion **50** of the locking element **5** remains spaced from the recess **45** of the plug **3**, and this state of the connecter assembly can be visually checked.

Then, with two sides of the top and bottom portions **34**, **36** of the plug **3** gripped by hand, parallel portions of the elastic legs **41** at the bottom are inserted in the accommodating portion **11** of the socket **2**, the state of which is well shown in FIG. **12**. At this time, the locking portions **42** of the elastic legs **41** are in abutment with the inclined surface **14** at the entrance of the accommodating portion **11** and remains at rest. When the head portion **50** of the locking element **5** is pressed from this state by a thumb for example, an inward moment acts on the elastic legs **41**. This inward moment causes the elastic legs **41** and the second legs **52** to be deflected inwardly, as shown in FIG. **13**, so that the locking portions **42** of the elastic legs **41** are fitted in the locking recess **15**. At this time, the restraint portions **53** of the locking element **5** are placed in their upper position, not to restrain the elastic legs **41** from being deformed.

As shown in FIG. **14**, at the point of time at which the locking portions **42** of the elastic legs **41** are fitted in the locking recess **15**, the second locking portions **55** of the locking element **5** are in abutment with the inclined surface **14** at the entrance of the accommodating portion **11**, and the first locking portions **54** of the second legs **52** are away from the step portions **61** of the elastic legs **41**. At this point of time, since the inward moment acts on the second legs **52**, when the head portion **50** of the locking element **5** is continuously pressed, the locking element **5** is lowered further.

Then, the second locking portions **55** of the second legs **52** are fitted in the locking recess **15**, as shown in FIG. **15**, and the locking element **5** is set in the second position in which the first locking portion **54** of the second legs **52** are locked in the locking recess **62**. Also, the restraint portions **53** of the locking element **5** are placed in position with their thicknesses decreased, though not shown, to restrain the locking portions **42** from being disengaged from the locking recess **15**. As a result of this, the plug **3** is prevented from being disengaged from the socket **2**. In the second position, the head portion **50** of the locking element **5** is sunk in the recess **45** of the plug **3**, as well understood from FIG. **11**, from the state of which one can visually check that the mechanical engagement between the socket **2** and the plug **3** is perfectly completed.

FIG. **16** shows the state that the socket **2** and the plug **3** are in engagement with each other before the locking element **5** is pressed further. In this state, the front ends of the first legs **51** of the locking element **5** do not reach step-like folded portions of the short-circuit clips **24** at intermediate portion thereof, so that the abutting portions **27** are still in abutment with the side surfaces of the pins **13** to keep the short-circuit condition. Then, the locking element **5** is pressed further and is brought into complete mechanical engagement, the state of which is shown in FIG. **17**. In FIG. **17**, the step-like folded portions of the short-circuit clips **24** at intermediate portions thereof are stretched by the front ends of the first legs **51** of the locking element **5**. As a result of this, the abutting portions **27** are moved away from the side surfaces of the pins **13** to release the short circuit between the pins **13**, and the electrical engagement is also ended completely.

As will be understood from above, the direction for the plug **3** to be engaged with the socket **2** is identical with the direction for the locking element **5** to be shifted from the first position to the second position. This can provide the result that the engagement of the plug **3** with the socket **2** and the shifting of the locking element **5** from the first position to the second position can both be performed in the same pressing motion of the locking element **5**. Thus, the mechanical engagement between the plug **3** and the socket **2** and the electrical connection therebetween can be completely ended in the single motion. Once the mechanical engagement of the plug **3** in the socket **2** is completed, it becomes impossible to take out the plug **3** from the socket **2**, unless only the locking element **5** is returned back to the first position from the second position.

As described above, according to the electrical connector assembly **1** according to the illustrated embodiment, the socket **2** is constructed to support the two pairs of first electrical connector elements **13** in proximity. This can eliminate the need to arrange the two sockets while making a position adjustment to bring the electrical contacts of each pair into alignment in series in each of the sockets, thus providing the result of facilitating the effective use of the connection space.

Also, since the plug **3** is constructed to support the two pairs of second electrical connector elements **30** as a unit, the double action commonly required for the engagement of the connector assembly can be reduced in half to the single operation.

Further, since the socket and the plug can be engaged with each other in only a limited orientation, the need to distinguish the two connector assemblies by using different colors or shapes for the purpose of preventing improper connection of the two connector assemblies is eliminated to begin with. In addition, the need to check the fitting positions of the connector assemblies is eliminated to begin with. Thus, in addition to reducing a component count, additional works, such as the color coding, and the checking work of the fitting positions can be cut.

Also, since the integrally formed locking element **5** can allow the two short-circuit elements **4** to move back to their non-short-circuit positions simultaneously, the release of short-circuit can be completed in only a single operation.

Thus, the present invention can provide an electrical connector assembly having a locking part that can provide a drastically improved working efficiency and thus provide excellent connection workability even when two pairs of electrical contacts are connected with each other.

In addition, according to the electrical connector assembly **1** according to the illustrated embodiment, since the two short-circuit elements **4** are also integrally formed as a unit, possible mistakes, such as the case that the two separate short-circuit elements may be wrongly assembled, can be prevented. Besides, the assembling work of the short-circuit elements **4** can be completed in only a single operation, and as such can provide an electrical connector assembly having a locking part of excellent in workability. Also, since the plug **3** is constructed to be received in the openings **18** of the integrally formed short-circuit elements **4**, the stable connecting structure can be provided for even the connector assembly having two pairs of electrical connector elements.

Further, according to the electrical connector assembly **1** according to the illustrated embodiment, when the locking element **5**, which is previously locked at the first position with respect to the plug **3**, is pressed down, the plug **3** is engaged with the socket **2** and also the locking element **5** locked at the first position is released simultaneously and then is pressed further into the second position. The locking element **5** operates to release the short-circuit of the short-circuit element **4** when it is in the second position. In other words, the connecting operation of the plug **3** and the socket **2** and the pressing operation of the locking element **5** to release the short circuit of the short-circuit elements **4** can be performed in the same motion as a whole.

While the present invention has been described on its preferred embodiment, it is to be understood that it is intended to cover in the appended claims all variants, modifications, applications and equivalents thereof that will be obvious as fall within the scope of the appended claims upon reading and understanding the specification.

For example, the pair of legs **26** of the short-circuit clip **24** may be presented in the form of a sheet of plate. The pair of abutting portions **27** formed by bending the front ends of the legs **26** at an angle of 90 degree may take any suitable configuration to directly contact with the pins **13**, without limiting to the configuration as shown in the illustrated embodiment.

Also, as long as the two short-circuit elements **4** are formed in one piece, the two short-circuit elements **4** may be formed into any suitable configuration, without limiting to the configuration wherein the two short-circuit elements **4** are connected to each other via the bridge portion **17**, as in the illustrated embodiment. For example, the two short-circuit elements **4** may be formed into an elliptic cylinder form or a like form.

In addition, the locking element **5** according to the present invention is applicable not only to the electrical connector assembly **1** according to the present invention that is so structured that the locking and the release of the short circuit can both be performed in the same motion, but also to a conventional type of electrical connector assembly that is so structured that the locking and the release of the short circuit are performed by different motions.

What is claimed is:

1. An electrical connector assembly used for an airbag system having two igniters for an airbag, for energizing and igniting a gas generator to inflate the airbag the electrical connector assembly comprising:

a socket for supporting two pairs of first electrical connector elements in proximity;

a plug for supporting two pairs of second electrical connector elements which are to be engaged with the two pairs of first electrical connector elements, respectively;

two short-circuit elements, fitted in the socket for electrically short-circuit the two pairs of first electrical connector elements, respectively; and

a locking element which is locked at a first position with respect to the plug thereby engaging the socket at the first position and, when the plug is engaged in the socket, becomes moveable to a second position at which the locking element forces the two short-circuit elements to move back to their non-short-circuit positions simultaneously.

2. The electrical connector assembly according to claim **1**, wherein the two short-circuit elements to short-circuit the two pairs of first electrical connector elements are integrally formed and having openings to receive the two pairs of second electrical connector elements, respectively.

3. An electrical connector assembly used for an airbag system having two igniters for an airbag, for energizing and igniting a 255 generator to inflate the airbag the electrical connector assembly comprising:

a socket for supporting two pairs of first electrical connector elements in proximity;

a plug for supporting two pairs of second electrical connector elements which are to be engaged with the two pairs of first electrical connector elements, respectively;

two short-circuit elements, fitted in the socket for electrically short-circuit the two pairs of first electrical connector elements, respectively; and

a locking element which is locked at a first position with respect to the plug thereby engaging the socket at the first position and, when the plug is engaged in the socket, becomes moveable to a second position at which the locking element forces the two short-circuit elements to move back to their non-short-circuit positions simultaneously,

wherein a direction for the plug to be engaged in the socket is identical with a direction for the locking element to move from the first position to the second position, so that the engagement of the plug in the socket and the movement of the locking element from the first position to the second position can be continuously performed in the same pressing motion of the locking element.

4. An electrical connector assembly comprising:

a socket for supporting two pairs of first electrical connector elements in proximity;

a plug for supporting two pairs of second electrical connector elements which are to be engaged with the two pairs of first electrical connector elements, respectively;

two short-circuit elements, fitted in the socket for electrically short-circuit the two pairs of first electrical connector elements, respectively; and

a locking element which is locked at a first position with respect to the plug and, when the plug is engaged in the socket, becomes moveable to a second position at which the locking element forces the two short-circuit elements to move back to their non-short-circuit positions simultaneously;

wherein the locking element has a pair of first legs extending substantially in parallel with each other and a pair of second legs extending substantially in parallel with each other, wherein the pair of first legs are to short-circuit the two pairs of first electrical connector elements, and the pair of second legs, which are disposed at such locations as to form a generally cross-shape by a line connecting between the pair of first legs and a line connecting between the pair of second legs, having locking portions to be locked at the first position and the second position with respect to the plug and the socket.

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